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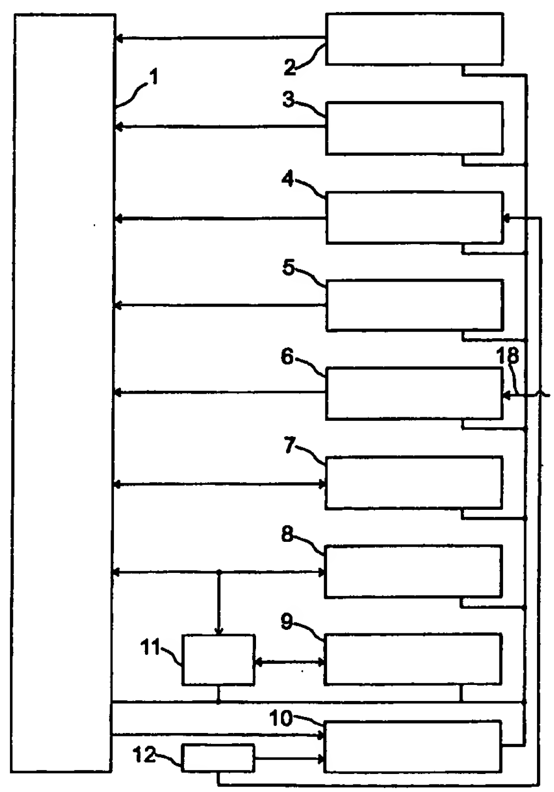
(54) Title: METHOD AND APPARATUS FOR CORRECTING A MEASURED VOLUME OF A FLOWING GAS

(57) Abstract

A method for correcting a measured volume of a flowing gas, in which the measured volume of the flowing gas is corrected on the basis of temperature and pressure of the gas, as well as of a correction factor characterising the gas, wherein from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, on the basis of the measured pressure and temperature of the flowing gas, a modified correction factor is determined, and the corrected volume is determined on the basis of the measured pressure, temperature and the modified correction factor. The invention relates also to an apparatus for correcting a measured volume of a flowing gas, the apparatus comprising a sensor (6) for sensing pulses coming from a gas meter, a temperature sensor (2) for measuring temperature of the flowing gas, a pressure sensor (3) for measuring pressure of the flowing gas, and a central unit (1) for correcting the measured volume on the basis of the temperature measured by the temperature sensor (2), the pressure measured by the pressure sensor (3) and a correction factor characterising the flowing gas, wherein the central unit (1) is designed for calculating a modified correction factor on the basis of the temperature measured by the temperature sensor (2) and the pressure measured by the pressure sensor (3) from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, and for determining the corrected volume on the basis of the measured pressure and temperature as well as the modified correction factor.



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Method and apparatus for correcting a measured volume of a flowing gas

TECHNICAL FIELD

The invention relates to a method and an apparatus for correcting a measured volume of a flowing gas.

BACKGROUND ART

With the energy prices on the increase, it is in the fundamental interest of the gas supplier and the consumer to measure consumption accurately. The initial figure of gas volume measurement serving as the basis of billing is the rough effective volume of the flowing gas, mostly measured by turbine or rotary piston flow meter. The rough effective volume of a given quantity of gas, however, is influenced by the gas temperature, pressure and composition. Therefore, the requirement arises to supplement the gas consumption meters with an electronic apparatus, the so-called PTZ corrector, which converts the measured effective volume to the standard state of the gas.

The effect of gas composition on the volume is corrected by the square of the supercompressibility factor, i.e. by the so-called correction factor. The supercompressibility factor depends on the composition, pressure and temperature of the gas. For calculating this factor, there are computer programs written in high level languages, which programs calculate with equations of state and experimental factors. However, at the current level of computer technology, these programs – due to limits in time and power consumption – may only be applied on personal computers or on other microprocessor systems with a high computing capacity, and it is not possible to run them on microcomputers of the category used in PTZ correctors.

The PTZ correctors may be supplied from the mains or from a battery. The battery-based PTZ correctors are mobile vis-à-vis the correctors supplied from the mains, and through their application, the explosion-safe requirements can generally be satisfied in a more simple and more economic way. One of the main

design problems of battery-based PTZ correctors is represented by the limited use of energy. However, the development achievements of recent years in electronics have enabled the reaching of a satisfactory battery lifetime with an acceptable amount of battery.

Examples for prior art PTZ correctors are the ROMBACH LEVC Zustands-Mengenumwerter and the RMG EC 685 "Junior" equipment. The common characteristics of these units are that they are fed from battery, and the correction is calculated on the basis of the measured temperature and pressure of the flowing gas and of the supercompressibility factor taken into consideration as a constant in the given temperature range. The advantage of these PTZ correctors is that they are fitted with electronic LCDs and function selector pushbuttons, which greatly facilitate their handling and the read-out of various adjustment and measured data. It is their disadvantage, however, that as a result of their structure and operation they have a high consumption, and therefore their battery lifetime is relatively short: 3 years, or – in the case of lithium batteries – 1 year. It is a further disadvantage that a correction with a constant supercompressibility factor could lead to a substantial correction error if the composition, temperature or pressure of the flowing gas changes.

DISCLOSURE OF INVENTION

The object of the invention is to provide a method enabling a higher correction accuracy for correcting the measured volume of a flowing gas, in which the correction factor is not taken into consideration as a constant, but it is determined on the basis of a basic correction factor characterising the flowing gas, in view of the measured gas pressure and temperature.

Another object of the invention is to provide a correcting apparatus enabling a higher accuracy measurement of the volume of a flowing gas than the known correctors, having a low consumption as a result of its design, thus featuring long battery lifetime, and enabling easy handling.

Thus, the invention is a method for correcting a measured volume of a flowing gas, in which the measured volume of the flowing gas is corrected on the basis of temperature and pressure of the gas, as well as of a correction factor

characterising the gas. According to the invention, from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, on the basis of the measured pressure and temperature of the flowing gas, a modified correction factor is determined, and the corrected volume is determined on the basis of the measured pressure, temperature and the modified correction factor.

The correction with a modified correction factor calculated from the basic correction factor results in a simple method and a higher metering accuracy.

In a preferred embodiment the modified correction factor corresponding to the measured pressure and temperature is determined by linear breakpoint approximation of a relationship between the correction factor and the temperature. Thereby the calculation requirement is substantially reduced, and this enables a more simple and low-cost design of an apparatus performing the method.

Preferably a linear breakpoint approximation with a single breakpoint is used and the location of the breakpoint is selected according to the nominal temperature or pressure, or on the basis of the basic correction factor. This further simplifies the correction calculations, which results in a lower energy consumption and thus in a longer battery lifetime.

Furthermore, the invention is an apparatus for correcting a measured volume of a flowing gas, comprising a sensor for sensing pulses coming from a gas meter, a temperature sensor for measuring temperature of the flowing gas, a pressure sensor for measuring pressure of the flowing gas, and a central unit for correcting the measured volume on the basis of the temperature measured by the temperature sensor, the pressure measured by the pressure sensor and a correction factor characterising the flowing gas. According to the invention, the central unit is designed for calculating a modified correction factor on the basis of the temperature measured by the temperature sensor and the pressure measured by the pressure sensor from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, and for determining the corrected volume on the basis of the measured pressure and temperature as well as the modified correction factor.

Calculating a modified correction factor results in a much higher correction accuracy than by considering a constant correction factor.

According to a preferred embodiment of the invention, the central unit is designed for calculating the modified correction factor corresponding to the measured pressure and temperature by linear breakpoint approximation of a relationship between the correction factor and the temperature. The linear breakpoint approximation enables a high accuracy approximation of the correction factor, while the approximation requires a low calculation capacity.

According to another preferred embodiment of the invention, the central unit is designed for applying a linear breakpoint approximation on the basis of a single breakpoint selected according to the nominal temperature or pressure, or according to the basic correction factor. This is a practical simplification of the calculation which extends the battery lifetime of the apparatus.

The apparatus preferably comprises a battery-based power supply and a pushbutton for entering the basic correction factor, wherein the pushbutton is designed for changing the value of the basic correction factor step-by-step by a predetermined quantity between an upper limit and a lower limit when pushed. The entering of the basic correction factor by a pushbutton results in a simple and low-cost design.

The apparatus preferably comprises a multifunction display for displaying calculated and measured data as well as constants, the display being switched on by means of a pushbutton and being automatically switched off after a predetermined period. The central unit is preferably activated periodically and switched automatically to a stand-by state after having performed said determination of the corrected volume. These solutions substantially reduce the consumption of the apparatus which results in a longer battery lifetime.

BRIEF DESCRIPTION OF DRAWINGS

The invention will hereinafter be described on the basis of a preferred embodiment depicted by the drawings, where

Fig. 1 is a block diagram of the apparatus according to a preferred embodiment of the invention,

Fig. 2 shows the change in the correction factor of a gas of a given composition, as a function of temperature and pressure,

Fig. 3 is the block diagram of the evaluation carried out every minute by the apparatus according to the preferred embodiment of the invention,

Fig. 4 is the rear view of the door of the apparatus according to the preferred embodiment of the invention,

Fig. 5 is a cross sectional view taken along line A-A in Fig. 4,

Fig. 6 is an axonometric view of the preferred embodiment with the door open, and

Fig. 7 is a front view of the preferred embodiment.

BEST MODE FOR CARRYING OUT THE INVENTION

In the block diagram shown in Fig. 1 a central unit 1 has been chosen in a manner that it is of low consumption (CMOS, in addition having a stand-by operating state), offering a perspective (having a presumably long product life) and high computing capacity as required by the calculations to be carried out by a battery-based PTZ corrector. The central unit 1 can be preferably the type of PIC16C71 manufactured by Microchip Technology Inc., because – in addition to its characteristics meeting the requirements above – it also has an integral analogue to digital converter, enabling it to become the compact as well as technically and economically preferred central unit of a system processing both analogue and binary signals. The central unit 1 contains programs handling the associated physical devices and the general system programs.

To analogue inputs of the central unit 1 a temperature sensor 2, a pressure sensor 3 and a battery voltage sensor 4 are connected. Temperature sensor 2, pressure sensor 3 and the battery voltage sensor 4 may be any unit of known design, provided that they have the appropriate accuracy. In the preferred embodiment described, the temperature sensor 2 is a 100 Ω platinum resistance thermometer, the advantage of which is that it is an accurate, steady and linear sensor and that its supplementing circuits are widely available. The temperature sensor 2 and the pressure sensor 3 are fitted with appropriate signal converters so that their output is directly connected to the analogue inputs of central unit 1. The microcontroller PIC16C71 comprises a 8-bit A/D converter, which provides sufficient resolution for the required measuring accuracy.

The pulses provided by a gas meter connected to the PTZ corrector are supplied to an input 18 of a pulse sensor 6. At the preferred embodiment we have taken into consideration a turbine gas meter, which is fitted with a potential-free contact pulse transmitter, emitting pulses up to 1 Hz frequency and having a pulse equivalent of 1 pulse/m^3. The central unit 1 receives at its binary inputs the output signal of pulse sensor 6 as well as the signals of pushbuttons 5. The binary signals activate the central unit 1, which is switched to stand-by state once the administration associated with the given binary input signal is completed.

The domestic and international regulations relating to the PTZ correctors may only be met by the electronic PTZ corrector if the consumption data are kept in a non-volatile memory 7. The non-volatile memory 7 preferably consists of an EEPROM, which can be electrically written and erased, and it is a memory that keeps its content even when the supply voltage is disconnected. The EEPROM may not be erased by an external influence and after an eventual power break-down (when the battery is disconnected or becomes flat), once the power is restored, it will contain the last consumption value. The non-volatile memory 7 includes the programs that perform correction and volume calculation, as well as programs for evaluating button actuations and controlling the display.

The depicted preferred embodiment comprises a display 9, which is a multifunction electronic dot matrix LCD. The display 9 is preferably a 1×16 character dot matrix display of the type VK 2016 manufactured by VIKAY, the advantage of which is that the size of the characters enables reliable reading under different light conditions. It is a further advantage, that of the sixteen characters eight can be used for displaying the numerical value part of the data, and so the domestic and international regulation that the display-counter may not turn over even at a maximum flow for 2000 hours can be complied with. The display mentioned above is also suitable for displaying alphanumeric characters, and so the remaining eight characters can be used to display the units of measurement and other non-digit information. The display 9 is controlled by a controller 11 which in connection with the central unit 1.

One of the pushbuttons 5 of the PTZ corrector is a display selector pushbutton, by the repeated actuation of which the following data will be displayed: corrected consumption, rough consumption, nominal temperature, nominal pressure, correction factor, status number. After 5 seconds, the displayed

data disappear and when depressing the display selector pushbutton again, the displayed sequence starts from the beginning. Vis-à-vis the normal operating display sequence, the following error messages enjoy priority, i.e. in an error condition upon the pressing of the display selector pushbutton, first the following appear: battery voltage reduction, temperature or pressure outside the plausibility limits, or measuring problem, respectively. By another pushbutton, the correction factor can be adjusted. This pushbutton drives the correction factor around between two limits in a specified number of steps, while it also appears on the display. In the described preferred embodiment, this pushbutton is protected with a seal so that it is not available to unauthorised persons.

Power supply is a critical problem of designing battery-based PTZ correctors. As explained above, the prior art PTZ correctors have a short battery lifetime, i.e. the battery is to be replaced frequently. For increasing the battery lifetime, a solar energy charger can be applied for example, which is, however, a very costly solution.

To avoid these disadvantages, the PTZ corrector according to the invention has been designed for minimum power consumption. As already explained, the PTZ corrector consists of low consumption CMOS circuits, and when they are inactive, the circuits are switched to stand-by state. The functional units having no such mode of operation – for example the display 9 – are switched off automatically after use.

The power demand of the PTZ corrector is met by a stabilised power supply 10 based on batteries 12. The estimated total consumption of the preferred embodiment of the PTZ corrector according to the invention is 1756 mAh for two years in view of the discussion above. This value is exceeded by the capacity of BRA lithium batteries (1800 mAh), but their use would not provide appropriate safety. Instead, it is advisable to fit BRC batteries, because they represent the next capacity stage of 5000 mAh. The lifetime of batteries 12 of the PTZ corrector according to the invention is thus increased to more than five and a half years, which covers two currently prescribed calibration periods.

The discharged condition of the batteries 12 supplying the power is checked by the battery voltage sensor 4 on the basis of a voltage measurement. Although the voltage/time characteristics of the batteries 12 depend on the load

and on the temperature as well, a rational comparation threshold voltage can be determined. The fact that the comparation threshold voltage has been reached is indicated by battery voltage sensor 4 through the display 9.

The PTZ corrector according to the invention furthermore has a real-time clock 8, which carries out timing, time measurement and data storage functions.

In view of the fact that the battery-based corrector is designed as a device of category C according to OIML where the range -25°C to +55°C is considered as a normal environmental condition, all integrated circuits and modules of the PTZ corrector are of the so-called type I (industrial temperature range: -40°C to +85°C).

The central unit 1 of the PTZ corrector carries out the logical and calculation operations on the basis of the following: the pulse signals from the gas meter, the measurement signals from temperature sensor 2 and pressure sensor 3, the binary signals of pushbuttons 5, the signals and data of real-time clock 8, the constants loaded by burning or by pushbuttons 5 (nominal temperature, correction factor etc.) and the values generated during the processing of the signals.

For converting the measured gas volume to normal state, the PTZ corrector uses the following formula:

$$V_N=V_m\cdot K_x\cdot(p_x/p_b)\cdot(T_b/T_x) \qquad (1)$$

where:

V_N is the corrected normal volume,

V_m is the rough measured volume,

K_x is the correction factor according to the given pressure, temperature and composition,

p_x is the measured pressure,

T_x is the measured absolute temperature,

p_b is the pressure of standard state and

T_b is the absolute temperature of the standard state.

As described in the introduction, the correction factor is the square of the supercompressibility factor. The supercompressibility factor is denoted by F_{pv}, and it can be calculated according to the following formula:

$$F_{pv} = (Z_b/Z) \tag{2}$$

where:

Z is the compressibility factor and

Z_b is the compressibility factor of the standard state.

F_{pv} is a function of the gas quality characteristics (composition, calorific value), the pressure and the temperature. There are computer programs for calculation of F_{pv} which use predetermined table values, equations of state and experimental factors. These programs, however, may not be run on microcomputers of the category used in PTZ correctors, due to the constraints defined partly by the computing capacity (time demand) and partly by the battery operation (power demand).

According to the invention this problem is solved by dividing the calculation of the correction factor into two parts. The parts of the calculation with high computing demand are performed by a programme written for this purpose and running on a personal computer. The inputs of the programme are the relative density and the CO_2 and N_2 content. The output of the programme is the basic correction factor K_b according to the nominal temperature (for example 15°C) and the nominal pressure (for example 101.325 kPa), which factor is to be loaded into the PTZ corrector by a pushbutton in the way described above.

Fig. 2 shows as an example the diagram of correction factor K_x of a gas as a function of temperature t_x and pressure p_x, the composition of which is 2.448% N_2, 0.975% CO_2, 92.325% CH_4, 3.285% C_2H_6 and 0.57% C_3H_8. It is shown by the diagram that if we calculated with K_b associated with the nominal temperature and nominal pressure as a constant, this would result in an error of approx. 3% between limits of 500 kPa to 1000 kPa and -25°C to +55°C. However, the curves of the diagram can be well approximated by two straight sections. A breakpoint between the straight sections can be chosen in the intersections of each curve and the nominal temperature. By this approach, the correction factor can be approximated between the limits above with an error lower than 0.25%.

The linear breakpoint approximation requires a computing capacity which is magnitudes lower than that of computing each point of the curve. Therefore,

this computing can be carried out by central unit 1 of the PTZ corrector. The central unit 1 performs the following actions.

On its pulse sensor 6, the central unit 1 continuously senses the pulses coming from the gas meter. Furthermore, the central unit 1 carries out every minute the correction calculation shown in Fig. 3.

As the first step of the calculation, from the number of pulses received in one minute, it determines the rough volume measured in one minute (in m^3 resolution), resets the counter which contains the number of pulses detected in one minute and performs temperature as well as pressure measurement.

As the next step, the correction factor is calculated according to the measured temperature and pressure, by the following formula, through a linear breakpoint approximation, by assuming that the network pressure remains in the ±15% range of the nominal pressure:

$$K_x=K_b\cdot[1+(T_b-T_x)\cdot p_x/(C\cdot p_b\cdot T_b)] \qquad (3)$$

where C is a correction constant.

Next, on the basis of the number of pulses, it calculates the accumulated uncorrected volume so that it can be displayed as required on display 9 of the PTZ corrector. As the next step, by considering the corrected remaining litres resulting from the previous minute evaluating and using the correction factor calculated on the basis of formula (3), the one minute and then the accumulated corrected volume is calculated in litres by means of formula (1). Finally, the calculation results as well as the corrected remaining litres resulting from the calculation are stored for use in the next minute evaluation.

Since on the basis of the description above, the display 9 in the preferred embodiment of the invented PTZ corrector shows the corrected and the rough accumulated volume in eight characters, at the time when the PTZ corrector turns over, when these digits exceed the 99,999,999 limit, their value is reduced by 100,000,000 and from then on the PTZ corrector will calculate with the new values so obtained.

The accuracy of the PTZ corrector according to the preferred embodiment is influenced by the uncertainty of temperature measurement and pressure measurement as well as by the inaccuracy of approximating the correction factor.

The error of up to 0.25% resulting from the approximating of the correction factor by the method above is much lower than the errors of these measurements, assuming a temperature sensor and pressure sensor of average accuracy.

The preferred embodiment of the PTZ corrector shown in Figs. 4 to 7 is designed in a steel sheet housing 13 providing appropriate protection, as an explosion-safe device. The protection of housing 13 is IP65, its size is for example 165 x 165 x 80 mm, and its material is a 3 mm thick electroplated and painted steel sheet. A painted aluminium door 14 of the housing 13 can be opened and it is fixed by four countersunk socket head screws. Within the housing 13, the electronic unit and the power supply 10 with the lithium batteries 12 are closed, encased units. The replacement of batteries 12 may only be carried out under non-explosive conditions.

The cables of temperature sensor 2, pressure sensor 3 and pulse sensor 6 reach housing 13 through the three stuffing boxes 16, and in the housing they are connected to terminals 17 fitted on the door 14.

The door 14 is designed in a manner that it directly carries the encased electronic unit and power supply 10 by means of spacers. The readability of display 9 is ensured by a glass panel 15 in door 14. Pushbuttons 5 can be operated by means of rubber grommets. The legends of the instrument are arranged on a plate flushed into the plane of the door 14, and made by an aluminium-graphic process, while the production licensing figures characterising the product are shown on a data plate riveted to the box.

The so designed PTZ corrector can be fitted on a support rack next to the pipeline of the flowing gas and to the gas meter. The PTZ corrector may also be designed in a way that it forms one mechanical unit with the gas meter. This approach, however, entails a slight modification of the meter design, and it is only justified when the PTZ corrector is applied for a particular type of gas meter.

CLAIMS

1. A method for correcting a measured volume of a flowing gas, in which the measured volume of the flowing gas is corrected on the basis of temperature and pressure of the gas, as well as of a correction factor characterising the gas, c h a r a c t e r i s e d in that from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, on the basis of the measured pressure and temperature of the flowing gas, a modified correction factor is determined, and the corrected volume is determined on the basis of the measured pressure, temperature and the modified correction factor.

2. The method according to claim 1, characterised in that the modified correction factor corresponding to the measured pressure and temperature is determined by linear breakpoint approximation of a relationship between the correction factor and the temperature.

3. The method according to claim 2, characterised in that a linear breakpoint approximation with a single breakpoint is used and the location of the breakpoint is selected according to the nominal temperature or pressure.

4. The method according to claim 2, characterised in that a linear breakpoint approximation with a single breakpoint is used and the location of the breakpoint is selected on the basis of the basic correction factor.

5. An apparatus for correcting a measured volume of a flowing gas, comprising a sensor for sensing pulses coming from a gas meter, a temperature sensor for measuring temperature of the flowing gas, a pressure sensor for measuring pressure of the flowing gas, and a central unit for correcting the measured volume on the basis of the temperature measured by the temperature sensor, the pressure measured by the pressure sensor and a correction factor characterising the flowing gas, c h a r a c t e r i s e d in that the central unit (1) is designed for calculating a modified correction factor on the basis of the temperature measured by the temperature sensor (2) and the pressure measured by the pressure sensor (3) from a basic correction factor corresponding to a nominal composition, pressure and temperature of the gas, and for determining the corrected volume on the basis of the measured pressure and temperature as well as the modified correction factor.

6. The apparatus according to claim 5, characterised in that the central unit (1) is designed for calculating the modified correction factor corresponding to the measured pressure and temperature by linear breakpoint approximation of a relationship between the correction factor and the temperature.

7. The apparatus according to claim 6, characterised in that the central unit (1) is designed for applying a linear breakpoint approximation on the basis of a single breakpoint selected according to the nominal temperature or pressure.

8. The apparatus according to claim 6, characterised in that the central unit (1) is designed for applying a linear breakpoint approximation on the basis of a single breakpoint selected according to the basic correction factor.

9. The apparatus according to claim 5, characterised by further comprising a battery-based power supply.

10. The apparatus according to any of claims 5 to 9, characterised by further comprising a pushbutton for entering the basic correction factor.

11. The apparatus according to claim 10, characterised in that the pushbutton is designed for changing the value of the basic correction factor step-by-step by a predetermined quantity between an upper limit and a lower limit when pushed.

12. The apparatus according to any of claims 5 to 9, characterised by further comprising a multifunction display (9) for displaying calculated and measured data as well as constants, the display (9) being switched on by means of a pushbutton and being automatically switched off after a predetermined period.

13. The apparatus according to any of claims 5 to 9, characterised in that the central unit (1) is activated periodically and switched automatically to a stand-by state after having performed said determination of the corrected volume.

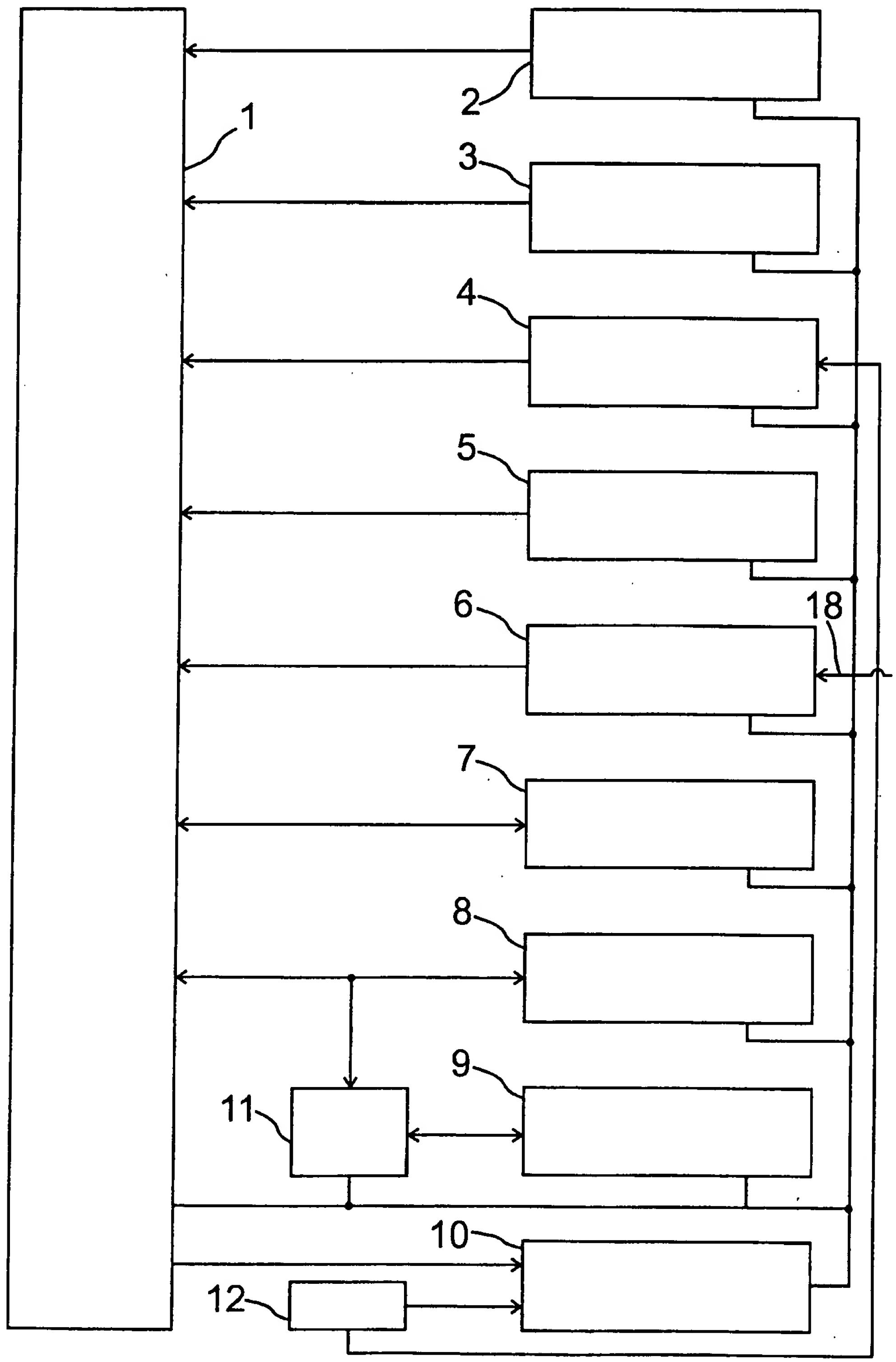

Fig. 1

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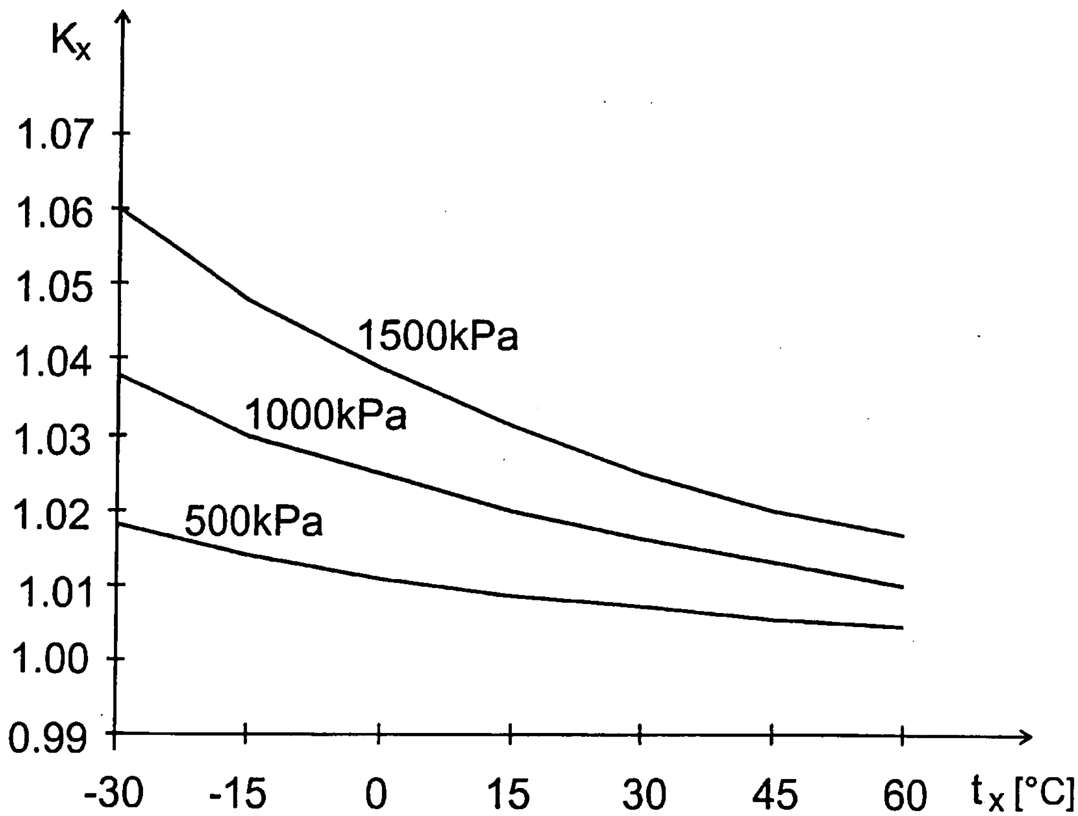
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1.06
1.05
1.04
1.03
1.02
1.01
1.00
0.99
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1000kPa
500kPa
-30
-15
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15
30
45
60
t_x [°C]

Fig. 2

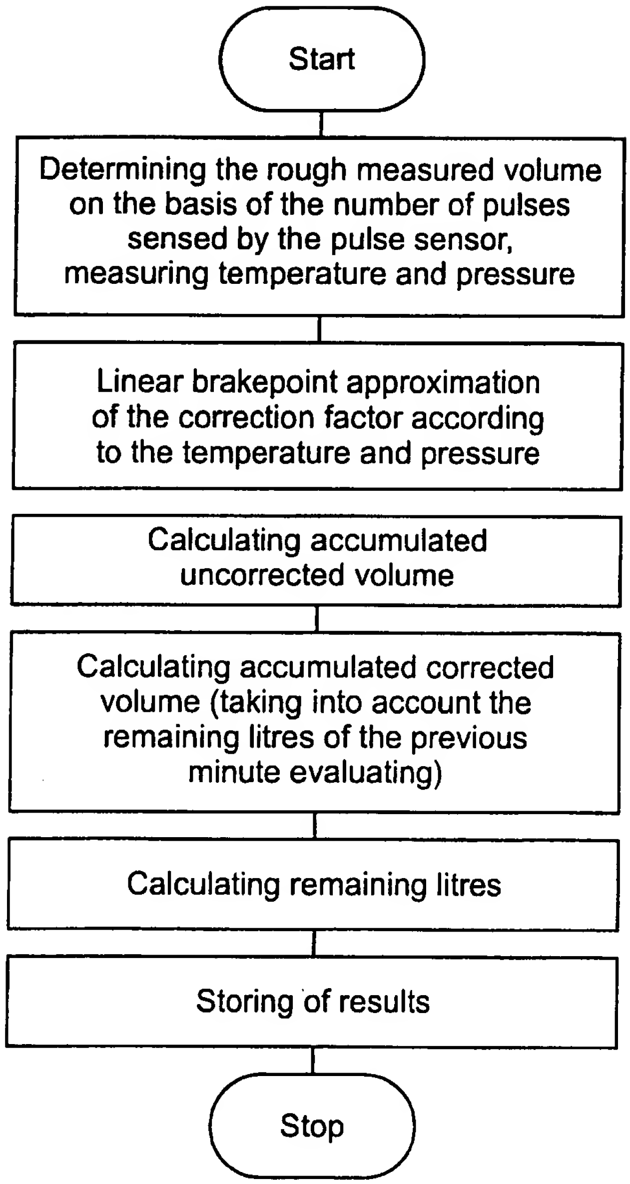
Start
Determining the rough measured volume on the basis of the number of pulses sensed by the pulse sensor, measuring temperature and pressure
Linear brakepoint approximation of the correction factor according to the temperature and pressure
Calculating accumulated uncorrected volume
Calculating accumulated corrected volume (taking into account the remaining litres of the previous minute evaluating)
Calculating remaining litres
Storing of results
Stop

Fig. 3

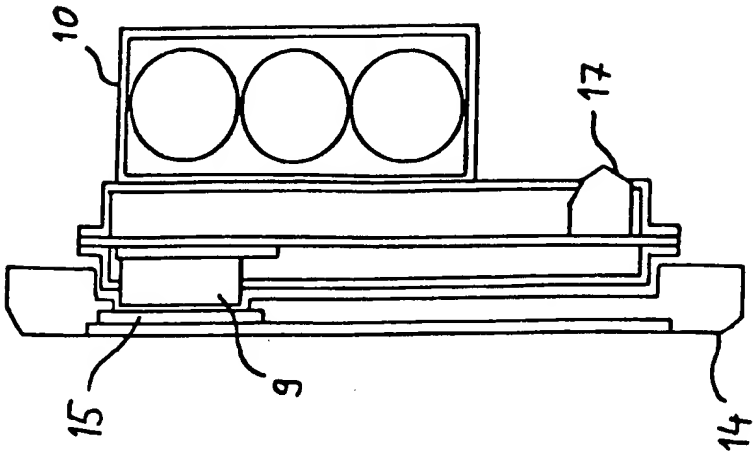

Fig. 5

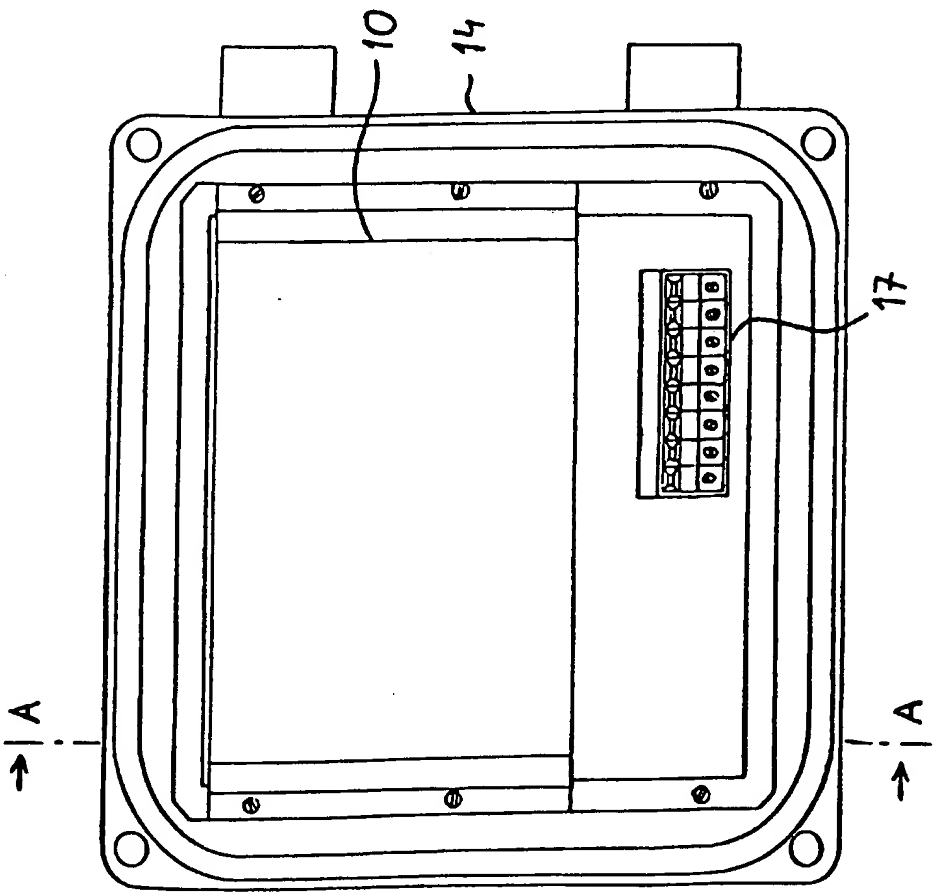

Fig. 4

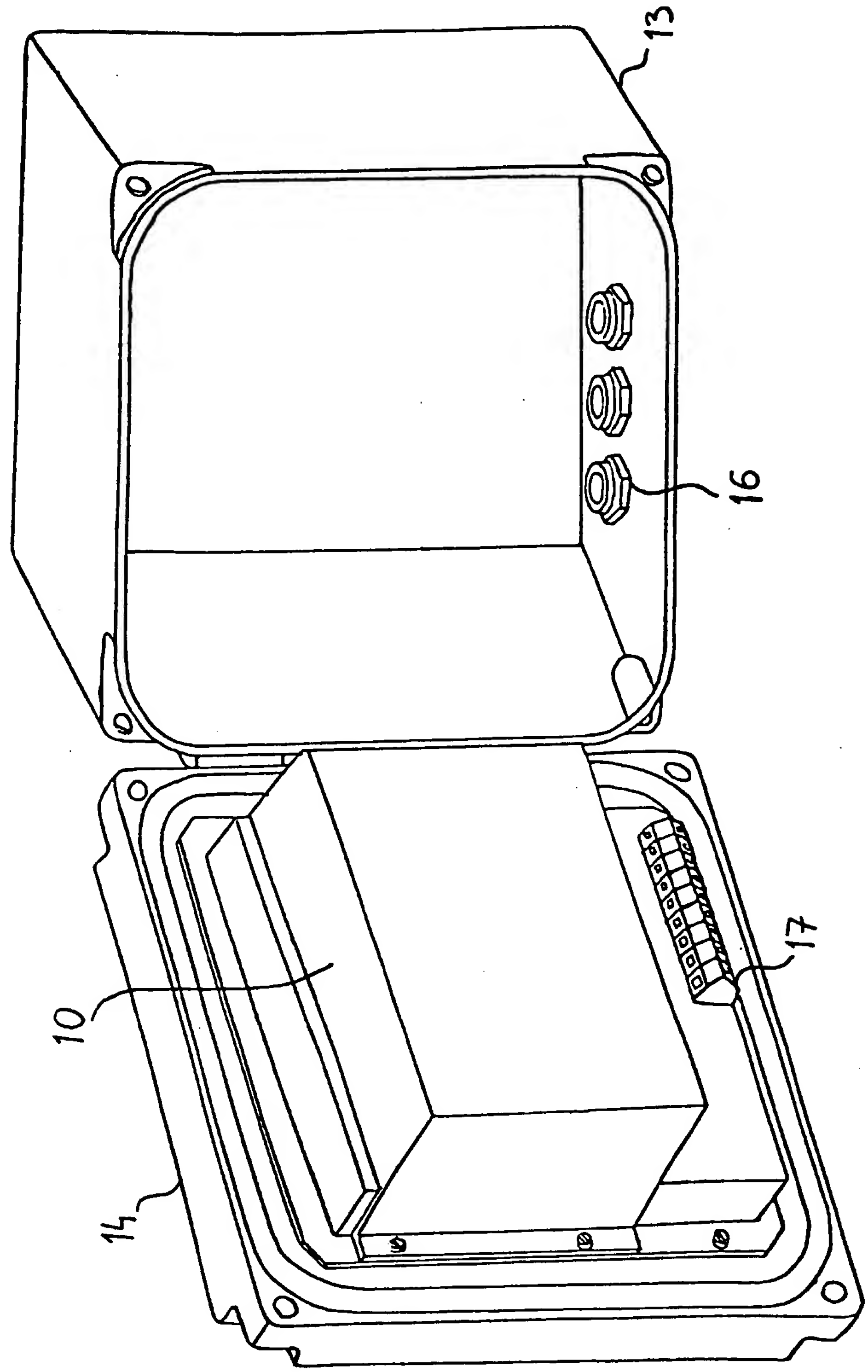

Fig. 6

WEST

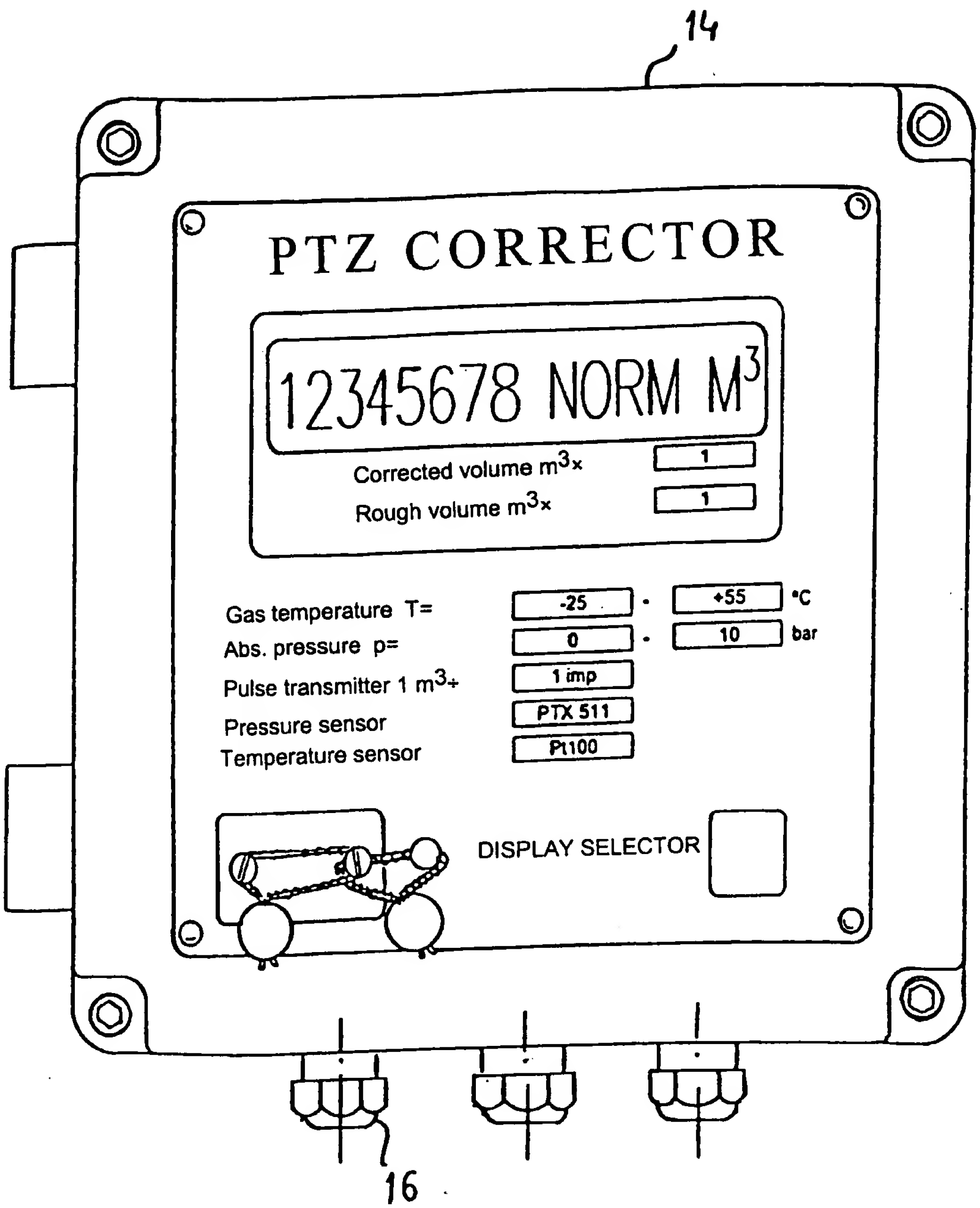
14
PTZ CORRECTOR
12345678 NORM M3
Corrected volume m3x
1
Rough volume m3x
1
Gas temperature T=
-25
+55
°C
Abs. pressure p=
0
10
bar
Pulse transmitter 1 m3÷
1 imp
Pressure sensor
PTX 511
Temperature sensor
Pt100
DISPLAY SELECTOR
16

Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/HU 98/00057

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01F15/04

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01F

Documentation searched other than minimumdocumentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GB 2 094 521 A (SINGER CO) 15 September 1982	1,2,5,6,9,12
A	see the whole document	3,4,7,8
X	GB 2 012 969 A (ROCKWELL INTERNATIONAL CORP) 1 August 1979 see the whole document	1,5,10
X	EP 0 236 681 A (ROCKWELL INTERNATIONAL CORP) 16 September 1987 see the whole document	1,5,9

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of theinternational search	Date of mailing of the international search report
28 August 1998	08/09/1998

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Rose, A

1

WEST

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/HU 98/00057

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